

# Chapter 5

## Input and Output Devices

This chapter addresses the issue of interaction of humans and the environment with the computer system. If you need to acquire a comprehensive knowledge about interaction with computers, like most areas in computer systems you need to have hands on experience in handling these components.

### 5.1 Input Devices

Input devices refer to any device that can provide an input of information, data or commands into the computer system. In a situation where we consider the CPU as the brain of the computer, the input devices act like the eyes, ears and any other sensory organ of the human body. Advance systems may have many input devices that can replicate all the senses on the human body. For example a humanoid robot will have all the sense of a human in addition to many more. In the case of a primitive and simple computer system the most common input devices are the keyboard and the mouse.

#### 5.1.1 Keyboard

The keyboard is also referred to as the primary input device of the computer system. This means that using the keyboard you can do the simplest input functions of entering data and commands to your computer system. The keyboard has a similar layout to the typewriter but has some additional keys that provide additional functionality than a typewriter. Keyboards come in different shapes and sizes but may differ in the number of additional keys.

The keyboards may be connected to the computer system through a wire or as wireless. The wired connection may be through the DIN-5 connector, PS/2 connector or USB. The wireless may use radio-frequency or infrared. In addition to the keyboard there is a special unit called a dongle, which can be connected to the USB interface of the computer system. This device is used by the computer system to communicate with the wireless keyboard.

##### 5.1.1.1 Standard keyboard

The standard keyboard has one hundred keys (figure 5.1). This set of keys can be divided into six categories.



Figure 5.1: Standard keyboard

- **Alphanumeric keys** - These include the alphabetical and numeric keys grouped together on the left side of the keyboard. The main function of these keys is to simply enter what ever symbol that is displayed on the particular key. Alphanumeric keys also include the “Tab, Caps Lock, Backspace, Enter and symbol keys”.
- **Modifier keys** - These keys are located on the bottom left and right corners of the grouping of the alphanumeric keys. These are the keys that modify the functionality of another key. This implies that the functionality of a particular key if pressed alone is different from the functionality if pressed with a modifier key. These keys include “Shift, Ctrl and Alt”. For example “Ctrl + S” does the saving of a file and “Alt + F” will display the file menu of your application.
- **Numeric keypad** - These are the set of keys that are located at the right most end of your keyboard. As the term implies the numeric keypad comprises of number keys from 0 to 9 and mathematical operator, numloc, enter and decimal keys. These help to enter numeric data faster that using the alphanumeric keys.
- **Function keys** - these are the keys located on the top most row of the keyboard and a labeled F1 to F12. These keys are allocated certain functions by different application. For example most applications allocate the function of showing the “application help” to the F1 key.
- **Cursor-Movement keys** - These are the keys that are usually located between the alphanumeric and numberpad keys. These cursor keys include the quad-directional arrows keys and the “Home, End, Page-up, Page-down” keys are the movement keys.
- **Special-purpose keys** - These keys are special keys usually located between the alphanumeric and numberpad keys which allow you to carryout special functions. These keys are the “Insert (also known as the overwrite), Delete, Print screen, Scroll Lock, Pause and Esc”
- Listed below are some of the functionality of a set of selected keys:
- **Caps Lock** - All alphabetical character you type will be in capitals
- **Num Lock** - When is on the numberpad will enter numbers when pressed, else it will function as the cursor-movement keys and special keys printed on them

- Esc - Exit of escape from a task
- Delete (Del) - Delete a file or the character on the cursor's right.
- Insert (Ins) - Overwrite the character on the cursor's right when Insert is On.
- Home - The cursor goes to the leftmost end
- End - The cursor goes to the rightmost end
- Page-up - Goes to the previous page
- Page-down - Goes to the next page
- Print Screen (PrtScrn) - Take a screen shot of the screen
- Pause/Break - Mainly used to pause and debug programmes
- Scroll Lock - Effects the movement of the cursor on scroll lock supporting programs. When On the cursor will be in the same location relative to the screen but the displayed file will move according to the arrow keys.

#### **5.1.1.2 Special keyboards**

There are a number of special keyboards available for your computer today. Some have special layouts, some are designed for a specific operating system, others are designed with special functionality and some are designed for keeping with special requirements and constraints. Some of the most common keyboard types are introduced below.

1. 101-key enhanced keyboard - The difference between the standard keyboard and the 101-key keyboard is that the 101-key keyboard has a similar layout to the standard keyboard with the exception of the "Enter" key. Furthermore the Tab, Shift and Caps Lock keys are larger in width and the Alt and Ctrl keys are located on both left and right bottom corners of the alphanumeric keypad. Some keys like F, J and numberpad 5 have home-row identifiers for touch typing. The function keys are spaced in groups of four and the Esc key is located at the upper left corner. The special purpose keys and movement keys are located above the dedicated cursor keys. The cursor keys are in the shape of an inverted 'T'.
2. 104-key Windows keyboard - This keyboard (figure 5.2) is similar to the 101-key keyboard in all ways except that there are three additional keys. The additional keys are the windows key, two of which are located between the Ctrl and the Alt keys and the application key with is located between the Ctrl and the Windows key on the bottom right corner of the alphanumeric keys. The windows key launches the Windows "start" menu. The application key provides additional functionality. For example the "Windows + E" would launch the windows Explorer program and the Application key on certain applications emulates the left click of the mouse.
3. Mac keyboard - The Mac keyboard (figure 5.3) is somewhat similar to the 101-keyboard. The main differences are that the modifier keys are shift, option and command, the backspace is the known as the forward delete key, the numberpad layout is different with four additional keys for audio and CD/DVD control, the keyboard has a power button on the top left corner and the apple key.
4. Multimedia and Web-enabled keyboards - Multimedia keyboards (figure 5.4) enable you launch you multimedia players and control your media player. The have control keys such as Play, Pause, Forward, Rewind, Next, Previous, Mute, Volume-up, Volume-down and

Eject. Web-enabled keyboards enable you to launch your web browser and use its navigation. These keyboards have control keys such as Launch Web Browser, Go Back, Go Forward and Home.

5. Ergonomic keyboards - The term “ergonomic” implies that something is designed to optimise human well-being, overall system performance and human comfort. Therefore ergonomic keyboards (figure 5.5) are keyboard that is designed to provide comfort of use and well-being for the user. Since using the keyboard a lot can cause strain to you hands and wrist, these keyboards are designed to minimise these stresses.



Figure 5.2: 104 Windows keyboard



Figure 5.3: Apple Mac keyboard



Figure 5.4: Multimedia keyboard



Figure 5.5: Ergonomic keyboard

6. USB keyboards with hubs - The layout of these keyboards may be in the form of the standard, 101-key, Windows or Mac keyboards. These keyboards are connected to the computer system through the USB interface. The additional feature of this keyboard is that it has a special USB hub where you could connect additional USB devices to the computer system through this hub.

It is important to note that the number of keys may change by one or two due to the reason that some keyboard manufacturers add more special keys to the keyboard.

#### **5.1.1.3 How the computer accepts keyboard inputs**

When a key is pressed the keyboard controller notes this action and writes the pressed key's scan code to the keyboard buffer. The keyboard controller is a chip that listens to the keyboard. The key's scan code is a code which uniquely identifies the pressed key. The keyboard buffer is a reserved area in the main memory which holds data until it is processed. The keyboard controller then sends an interrupt request to the system software that something has happened. An interrupt request is a special signal which only tells that something has happened but not what has happened. Since it is the keyboard controller that has sent the interrupt request the system software can respond to it in an appropriate time. When responding to the interrupt the system software can read the scan code in the keyboard buffer. Next the scan code is passed to the CPU and the appropriate part of the program which is related to that particular key is executed.

The driver of the keyboard also plays an important role in how the key presses are interpreted. If the correct driver is not installed the scan code of some keys may not be recognised by the system software. Hence some of the keys may not function or may cause unintended responses.

The keyboard layout needs to be specified to the system software. This defines how the scan code is interpreted by the system software. For example the location of keys Y and Z in the US keyboard are interchanged in the German keyboard. Many other key locations maybe changed according to the keyboard layout specified to the system software.

## 5.1.2 Pointer devices

Any location on the computer screen can be addressed by using X-Y coordinates. Pointer devices as the name implies are used to point to specific location on the computer screen. By moving the pointer device you can move the pointer on the computer screen and thereby identify any point on the screen. This principal can be used to identify icons, buttons and text etc. displayed on the screen. By clicking a button on the pointer device you could execute a icon click, button click or text selection etc.

### 5.1.2.1 Mouse

The mouse (figure 5.6) is the second most common input device after the keyboard. The X-Y Position indicator for a display system was invented by Douglas Englebart in 1964. This device was later called the mouse.



Figure 5.6: Mouse

The mouse comprises of four parts.

1. A ball/roller or optical sensors that indicate the mouse motion
2. Buttons and/or wheel that are used to make selections and scroll
3. A housing that holds the above components and lets you move the mouse around
4. An interface to connect to the computer system.

The mouse can be categorised into two types according to their motion sensing mechanism.

- The Ball mouse uses a ball/roller. When the mouse is moved the perpendicular wheels touching the ball moves and sensors at the end of these wheels indicate the direction of motion. The disadvantage of the ball mouse is that it gathers dust and debris, which cause erratic motion (figure 5.7).
- The optical mouse uses a light and an optical sensor. The advantage of the optical mouse is that it needs no pad and works on most types of surfaces. One disadvantage is sometimes the optical mouse is oversensitive and is difficult to control on some surfaces (figure 5.8).



Figure 5.7: Ball mouse dismantled

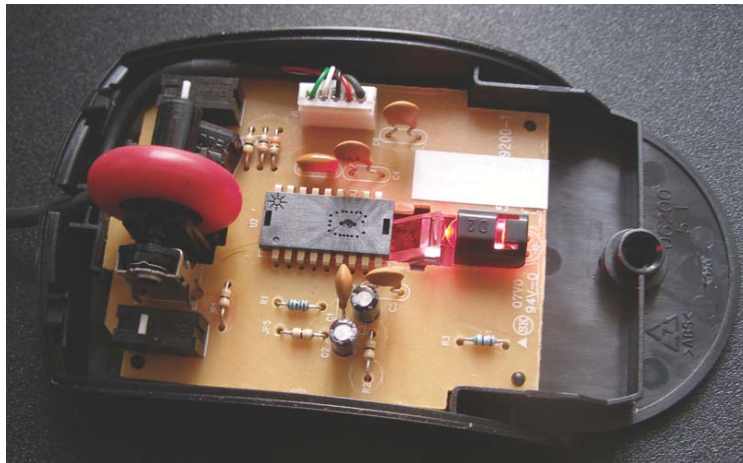


Figure 5.8: Optical mouse dismantled

The mouse rolls on a flat surface, preferably a mouse pad. The motion of the mouse is picked up by the sensors and passed through the interface to the computer system. The system software decodes this motion data and appropriately moves the pointer on the computer screen. The required task can be executed by clicking the mouse buttons.

The interface between the mouse and the computer system may be wired or wireless. The wired connection may be through the serial port, PS/2 connector or USB. The wireless may use radio-frequency or infrared. In addition to the mouse there is a special unit called a dongle which can be connected to the USB interface of the computer system in the wireless mouse. This device is used by the computer system to communicate with the wireless mouse.

### 5.1.2.2 Trackball

The trackball (figure 5.9) works like an upside-down mouse. The ball is on the top of the device where as the mouse ball is on the underside. The mouse has to be moved around whereas the trackball remains stationary. The fingers are used to move the ball. The track ball consists of buttons similar to the mouse. Trackballs are commonly used when there is a constraint on space. The mouse needs a considerable area to operate but the trackball is stationary hence requires very limited space. The best example is the use of a trackball in laptops where you do not have space for a mouse.



Figure 5.9: Trackball

### 5.1.2.3 Touchpad

The touchpad (figure 5.10) is also referred to as the trackpad. The touchpad was invented by Cirque in 1994. This is a square area about 2 inches by 1.5 inches. The finger is used to move around on the touchpad and this mimics the movement of a mouse. Touchpads are found most commonly on laptops but are available as individual units as well, which can be connected to the computer system in the way you connect the mouse. The touchpad works by sensing the position of the finger through body capacitance. Like the mouse the touchpad consists of two or more buttons. In addition to this the touchpad is “strike-sensitive” which means by tapping once or twice you could mimic the left single and double clicks respectively.



Figure 5.10: Touchpad

### 5.1.3 Other devices

This section addresses other devices which have a similar functionality to pointer devices and are used to interact with the computer system and the GUI.

#### 5.1.3.1 Pen

The pen (figure 5.11) which is also referred to as the stylus is used to write on a special pad or directly on the screen. The pen is commonly used for data entry on PDAs, handheld computers, tablet PCs, smart phones and palmtops. The operation of selecting and clicking of a mouse can be done using the stylus by tapping on the screen or pad.



Figure 5.11: The Stylus and a PDA

There are two ways to enter text in many of the above mentioned devices. The first method is by touching the keys of the virtual keyboard (figure 5.12) displayed on screen with the pen. The second method is by using a technology called handwriting recognition (figure 5.13) to identify the text you are writing on the screen or pad. The second method may seem very appealing but the technology of handwriting recognition is not hundred percent accurate.

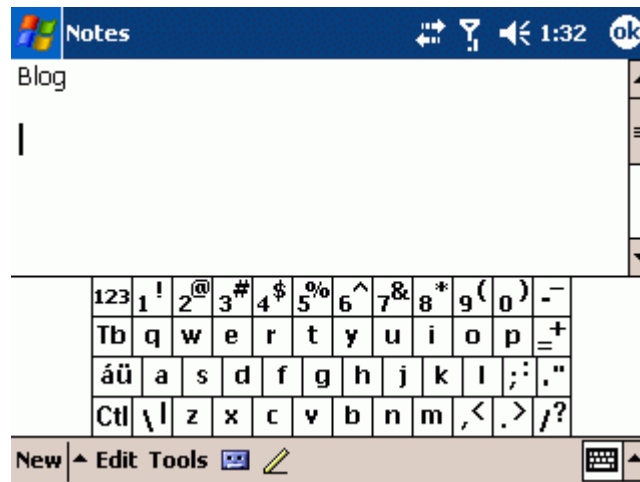


Figure 5.12: Virtual Keyboard on the PDA



Figure 5.13: Handwriting on PDA

### 5.1.3.2 Touch screen

The touch screen (figure 5.14) is a display screen which has sensors or capacitive film to locate where the finger is touching the screen. These are commonly used in locations where using a mouse or keyboard is not feasible and an intuitive interface is required. The buttons or icon on the screen can be pressed by the finger and the appropriate action will be taken by the computer. Touch screens are very popular on automated teller machines, point of sales at supermarket and fast food outlet, and public information systems etc.

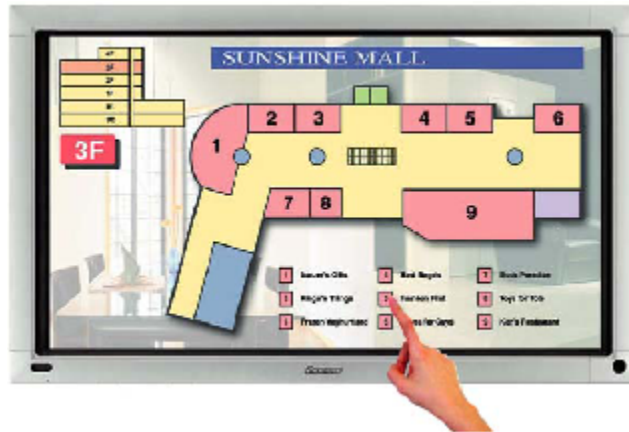


Figure 5.14: Touch screen

### 5.1.3.3 Joystick and Game Pad

With drastic improvements in multimedia on computer systems, games have become a very popular mode of entertainment. With the graphics, sound and motion becoming more and more realistic, it has become important to provide more realistic controls to the game player. The Joystick (figure 5.15) and the gamepad (figure 5.16) may also be referred to as Game Controller. These devices are connected to the computer system through the game port which is a 15-pin connector usually available on the sound card or I/O card.



Figure 5.15: Joystick



Figure 5.16: Gamepad

## 5.1.4 Optical devices

Optical devices use light to capture data and input it into the computer system.

### 5.1.4.1 Barcode readers

Barcodes (figure 5.17) are a set of dark lines that are used to uniquely identify an item or product. Barcodes are found in many products ranging from books to canned fish. Due to this reason barcodes are used in libraries, bookstores, warehouses, supermarkets and many other places. This is a convenient way of entering data without using a mouse or a keyboard by simply swiping the printed barcode under the barcode reader.

Barcode readers (5.18) are commonly available as flatbed and handheld. Flatbeds are mostly seen in supermarkets and retail stores where as handheld are commonly used in libraries and bookstores. These emit strips of LASER light and the reflected image is picked up by the light sensors. The captured image is processed and the barcode is identified and passed on to the computer system as an alphanumeric value. This value can be processed by the program and a suitable response can be executed.



Figure 5.17: An image of a barcode



Figure 5.18: Barcode reader

#### 5.1.4.2 Scanners and OCR devices

Scanners are used to capture printed image into an electronic format. This is done by shining light onto the image and capturing the wavelength of light reflected at each point of the image. The wavelength at each position is plotted to a two dimensional array that creates an electronic image file. This image file can be then manipulated using software.

If the printed image is a collection of text, there is special software called Optical Character Recognition (OCR) software that can process the captured electronic image file and recognise the text on it to create a text file. These software are very accurate for printed materials like books but not so accurate for handwritten documents.

Like barcode readers scanners are also available as flatbed (figure 5.19) or handhelds (figure 5.20). The accuracy of flatbed scanners is much higher than that of handheld scanners. The reason for this is that the speed of the motion of the light sensor is constant for the flatbed but the handheld speed of the sensors varies according to the speed of your hand.



Figure 5.19: Flatbed scanner



Figure 5.20: Handheld scanner

## 5.1.5 Audiovisual devices

Audio means sound or audible noise, and visual means still or moving images. Therefore audiovisual input devices are any devices that can capture and transfer sound, still images or video. Most modern day audiovisual input devices are able to capture sound and video or still images.

### 5.1.5.1. Microphones

The microphone (figure 5.21) is the device used to input sound into the computer system through the sound card. The microphone aids in recording speech, communicating through voice and providing voice commands to your computer system. Voice recording can be used for tasks like dubbing presentations and animations etc. Communication can be achieved through voice over IP telephony and voice chat etc. If your computer system has voice recognition software it can recognise your voice command and execute appropriate actions.



Figure 5.21: Microphone

### 5.1.5.2 Video Input

Video input devices also referred to as video cameras come in many sizes, different recording qualities, different storage mediums and in analog and digital forms.

The webcam (figure 5.22) can be considered the most primitive type of video camera, where it captures the image and transfers it directly to the computer system. The image are of low quality and low resolution which make the captured video file small in size and suitable to be transmitted over the internet. This is the reason that this camera is referred to as the webcam. It is important to note that the webcam does not support the capture and transfer of sound. If you are using the webcam you have to use a microphone to capture the sound.



Figure 5.22: Web camera

Another more advance video camera is the analog video camera. These can capture and store analog video on magnetic tapes. These cameras also capture sound. The only disadvantage in these cameras is that you need a special video capture card or device to convert the analog audio and video into digital format to store on the computer system.

Some of the more advanced digital cameras are DV and DVD cameras (figure 5.23) . The DV camera stores the audio and video on DV tapes in digital format. These can be transferred to the computer through the Firewire interface. The Firewire interface allows the control of the camera playback through a GUI on the computer system. The only disadvantage is that the time it takes to transfer the video is equal to the recorded time of the video. The DVD cameras directly write the video on to a mini-DVD. These can be read using a DVD-ROM and copied to the computer using DVD-ripping software.



Figure 5.23: DVD camcorder

The most convenient video cameras are those with digital memory cards that directly store the video and audio as a single file on the memory card. The memory card is displayed like another disk drive on your computer system when you connect the video camera to the computer system. The video file simply can be copied like you would copy any other file.

It is important to note that video cameras are capable of capturing still images as well. The quality of the still image may not be as good since video cameras are optimised to capture video and not still images.

### 5.1.5.3 Digital cameras

The difference between digital cameras (figure 5.24) and video cameras is that digital cameras only capture still images and store them in a digital memory card. Most often the image file is compressed and stored on the memory card to allow a large number of photographs to be taken. The memory card is displayed like another disk drive on your computer system when you connect the digital camera to the computer system. These images stored on the card can be transferred to a computer like copying a file from one drive to another.



Figure 5.24: Digital camera

## 5.2 Output devices

We talked about the processor being the brain of the computer and the input devices being our eyes and ears. Similarly our hands and mouth are our actuators and are used to communicate our thoughts. The computer uses output devices to transfer information to the environment and the user.

### 5.2.1. Monitors

Monitors are the primary output device of a computer system. Monitors provide us with a graphical representation of information on the screen. Two types of monitors are most common in computer systems. They are:

- CRT monitors
- Flat-Panel

#### 5.2.1.1. CRT

CTR stands for Cathode Ray Tube. CRT monitors (figure 5.25) use cathode ray tube technology. This is the technology commonly used in television sets. The monitor tube is a glass vacuum tube with one end having an electron gun that projects three beams and the other a display surface coated with phosphors. When the electron beam strike the coating it glows with the particular colour. The three electron beams are intended to glow the red, green and blue phosphors.



Figure 5.25: CRT monitor

The electron beams are controlled by the focus control coil and the deflection coil. This enables the electron beams to be focussed onto a specific location of the phosphorus screen. The mixture of the colours red, green and blue can create any given colour. One of these focus points is known as a pixel. By colouring all the pixels with different colours an image is created on the screen. The electron beam scans the screen horizontally and vertically at a given number of times per second. This determines how often the electron beam refreshes a particular location on the screen. This parameter is known as the refresh rate. The higher the rate the lesser flickering you see on the screen.

The CRT monitors use high voltages to create electron beams and this requires a large amount of electricity. This is a disadvantage of the CRT monitor. Furthermore since the CRT monitors deal with large voltages it is dangerous to dismantle a CRT monitor even if has been switched off. The CRT monitor also emits a certain amount of radiation which is considered a health hazard. In addition to this CRT monitors also produce a large amount of heat.

#### **5.2.1.2. Flat-Panel**

The most common type of Flat-Panel (figure 5.26) monitors is the Liquid Cristal Display (LCD). The LCD was first used in digital calculators and wrist watches etc. and usually worked in monochrome (one colour). Next the LCD technology was adapted for the screens on laptop. During this adaptation the LCD technology could not be used as a monochrome technology and was developed to support a full spectrum of colours. A back-light was also introduced to illuminate what was displayed on screen. The LCD screen is a grid of liquid crystals. The orientation of the liquid crystals in a particular pixel is changed by a small current sent along the rows and columns of the LCD grid. When the orientation changes so does the colour of the pixel. By colouring all the pixels on screen an image is created. The LCD display has a refresh rate which is similar to that of the CRT monitor.



Figure 5.26: Flat-Panel LCD monitor

This original laptop technology has now been adapted for desktop monitors. The advantage of the LDC panel over the CRT is that has a flat screen, consumes very little space, has better colour quality, consumes about 5% of the power used by a CRT, has low glare and produces no radiation and little heat. The disadvantage of the LCD panel over the CRT is that it requires a special back-light and has low contrast, has a limited viewing angle and are more expensive to manufacture.

Most modern day colour display mobile and smart phones, PDAs, Digital and video cameras, portable DVD players and many more digital devices use LCD technology for the display.

#### **5.2.1.3 Other monitor types**

Some of the less common monitors are listed below. They may use different technology and have different purposes.

- Electroluminescent displays - These are similar to LCD panels, but instead of using liquid crystals they use phosphorus film sandwiched between two layers of film. Like the LCD display by energising a particular row and column a particular pixel can be coloured. The advantage of this is that these have higher contrast and brightness and do not require a back light.
- Plasma display - These function in a similar way to LCD and electroluminescent displays. The difference is that instead of liquid crystals or phosphorus, these displays use gas sandwiched between two films. These displays are inexpensive, provides high quality images, do not require a back light and can be much larger than a LCD panel. This technology is used for large screen TVs (figure 5.27).
- Paper-White displays - These monitors are used by individuals who create high quality graphics like graphic designers for advertisements, news paper and magazine and desktop publishers.



Figure 5.27: Plasma TV

### Key features

There are many issues that you need to consider when purchasing a monitor. A good monitor will be easy on your eyes and allow you to work for longer periods of time with comfort. A bad monitor will cause eye strain and in the long run could harm your eyes. Therefore it is important to consider some features when purchasing a monitor.

The key features of a monitor are:

- The size of the viewing area - usually stated in inches diagonally
- Resolution - The maximum number of pixels across and from top to bottom
- Image contrast - The contrast between colours
- Image brightness - The brightness of the display
- Power consumption and management - the amount of power it uses and its power management features

- Refresh rates (Vertical and horizontal) - the number of times a second it refreshes the screen
- Price - monetary view of the investment for the monitor. For example if you are using the monitor for long periods it is better to purchase a high priced, low power consuming LCD panel, but if your usage is not that frequent you could go for a low cost CRT monitor.

### 5.2.2. Multimedia projectors

Multimedia projectors were a highly priced device. They were usually limited to conference halls, board rooms and other training facilities. With the improvement of technology and the large scale production, the prices of multimedia projects dropped drastically making it affordable for schools, institutes, universities and other organisations. They have also become so affordable that individuals increasingly replace large screen TVs and plasma TVs with multimedia projectors. Most homes now have mini theatres and multimedia projectors are used to project the videos on to the screen.

There are two types of technologies used for multimedia projectors.

1. Liquid crystal display (LCD) - The projector lamp is shone through a LCD display with the image, and the image is then projected onto a screen. These projectors are not that bright therefore require a dark room. Furthermore the images are not sharp but blur. These projectors also require a considerable time to cool down. The advantage of these projectors is that they are low cost (figure 5.28).
2. Digital light processing (DLP) - These have a special microchip called the Digital Micromirror device, which use mirrors to manipulate the image that is projected. The images projected by the DLP projectors are sharp not blur and brighter. Therefore they can be used to project images on normal light conditions. Furthermore these projectors are compact and small in size and take very little time to cool down. The disadvantage of these DLP projectors is that they are expensive (figure 5.29).



Figure 5.28: LCD Multimedia projector



Figure 5.29: DLP Multimedia projector

### 5.2.3. Sound systems

Computers have more support for multimedia that ever before and are improving by the day. Computers have wide screens to view movies, the video graphics cards are complex and provide unimaginable features for graphics, animations, movies and realistic 3D games, the main memory is referred to in Gigabytes and the DVD drive is a standard component. The video component of multimedia is really advanced but the audio component is not far behind.

The sound card (figures ?) and speakers have become a standard component in a computer system. The sound card converts the digital audio data into an analog form during playback. During recording the sound card converts the analog signal into digital data and stores it on the disk. Some of the modern sound cards have capabilities of conducting studio quality recording and playback. They have all types of input and output interfaces. Most electronic musical instruments can be directly connected to these sound cards through MIDI connectors etc.

With the sound cards supporting such high quality speaker systems have evolved to deliver their features. The sound system started off by having one or two speakers, then developed to have one sub-woofer and two speakers (referred to as the 2.1 system) and the most modern systems have one sub-woofer and seven speakers (referred to as the 7.1 system figures 5.31). These systems provide real 3D surround sound.

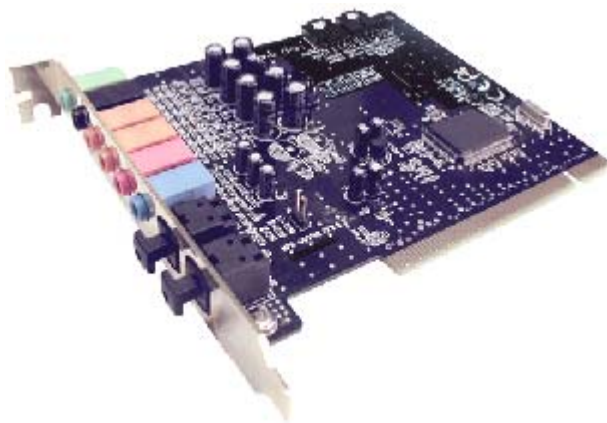


Figure 5.30: 7.1 surround sound card



Figure 5.31: 7.1 surround speaker system

In addition to this some people also use headphones (figure 5.32) for clarity sound and when only they need to hear (e.g. when having a online audio-chat) the audio or they need maintain silence of the surroundings (e.g. in a library).



Figure 5.32: Headphones

The sound card use a colour code for the 1/8 inch mini-jack connectors.

- Stereo audio out - light green
- Stereo audio in - light blue
- Microphone mono in - pink
- Game port/MIDI connector - Orange or Gold
- Stereo Front or Rare audio out - No standard colour

## 5.2.4. Printers

The printer is the device that provides you with a hard copy output. Unlike monitors and other output devices which provide an output which is not tangible, the printer provides a tangible output. Printers are generally categorised into two types.

1. Impact - The printing occurs by pressing an inked ribbon against the paper. These printers use pins of shapes embossed on steel hammers.
2. Non-impact - There are no components that touch the paper, but ink is sprayed on to the paper or toner is sprayed onto the paper and then thermally bonded.

### 5.2.4.1. Dot matrix

These printers are usually used in organisations that need to print documents with a large amount of text, some low quality graphics like graphs, a large number of pages, but do not require high quality prints.

These printers work by striking a set of pins arranged in one or more columns (contained in the printer head) against an inked ribbon to create an image by dots on the paper. This is the reason it is called the dot matrix printer. The minimum number of pins in a head is 9 and the maximum is 24. The 24 pin printer creates a higher resolution printout but the takes a longer time to print. The speed of dot matrix printers is stated in characters per second (cps).

Dot matrix printers (figure 5.33) can print on individual sheets of paper but mostly they use tractor-feed or continuous-feed paper. Continuous-feed papers are papers that come in one long sheet with the sides having rows of holes that fit onto the tractor rollers. The sheet of paper is separated by perforations (tear-offs).



Figure 5.33: Dot matrix printer

### 5.2.4.2. Ink Jet

These printers print by spraying different coloured ink directly onto the paper through tiny nozzles (figure 5.34). These printers have a medium resolution but have a very low ppm (papers

per minute) value. When compared to laser printer these have a very low initial cost and operational cost. Ink jet printers can print photographs and other graphics. Using special photo quality paper and high resolution printing these printers can print good quality images. A disadvantage of this printer is that if the printout gets wet the ink would blot and spoil the printout.

Ink jet printers use a combination of colours to create colour printouts. Some use:

- Cyan-Yellow-Magenta (CYM) and sometimes black.
- Red-Green-Blue (RGB) and sometimes black.



Figure 5.34: InkJet printer

#### **5.2.4.3. Laser Jet**

These printers use toner which is sprayed onto a paper that is charged with static electricity in the shape of the negative of what needs to be printed. Negatively charged toner is sprayed onto the paper. The charged toner is neutralised by the static charged area of the paper, but toner sticks onto the uncharged areas of the paper. The neutralised toner is brushed off by special rollers. The paper is sent through warm rollers and the plastic coating on the toner stuck onto the paper melts and stick to the paper. This creates an image on the paper (figure 5.35).



Figure 5.35: LaserJet printer

Laser printouts are of higher quality than most other printers. These printers can print up to about 1800 dpi (dots per inch). These printers also have a higher ppm value. The price of the laser printers increases with the increase of the resolution, speed and colour. Usually the price of a laser printer is about three or four times that of an ink jet printer. Furthermore toner cartridges need to be replaced after a couple of thousand prints. The toner cartridges are much more expensive than ink jet cartridges. Therefore the operation cost of laser printers is usually higher. Laser printers are not common for personal use, but are frequently found in office environments and are usually shared through the office network.

#### **5.2.4.4. Other Printers**

There are printers which are not as common as dot matrix, ink jet or laser printers. Some of them are listed below.

- **Plotter** - Plotters are mostly used to print large images such as Computer Aided Design (CAD) drawings, construction plans and engineering drawings which are too large to be printed using a conventional printer (figure 5.36).
- **Photo printers** - Most photo printers use the ink jet technology. Most often they use a different type of ink that is not water soluble and photo quality paper. There are large scale photo printers that can print photo enlargements and other large dimensional images. Photo printers can work without a computer and can directly read an image from a memory card or from the camera. This is a very convenient way to print photos taken from a digital camera (figure 5.37).
- **Thermal-Wax printers** - These printers are used for presentations and handouts. These printers have a low cpp (copies per minute) value. Therefore these printers are commonly used for prints like posters and book covers. These printers use a colour wax coated ribbon which melts and adheres to plain paper when passed over a focussed heat source (figure 5.38).
- **Dye-Sublimation printers** - These printers create high quality and sharp images. These printers are used by graphics artists and desktop publishers. The disadvantage of this printer is that they are slow, costly and the special paper they require is also expensive (figure 5.39).



Figure 5.36: Plotter



Figure 5.37: Photo printer



Figure 5.38: Thermal-Wax printer



Figure 5.39: Dye-sublimation printer

#### 5.2.4.5. Key features

It is important to consider some key features when purchasing a printer. They can be addressed through answering some simple questions.

What do you plan to use the printer for?

- How often will you be using the printer?
- What type (colour or black and white) of printouts will you be taking?
- Will you be printing only text or graphics or photographs etc.?
- How fast do you want your printouts?

After answering these questions you can start considering a printer on the following features.

1. Image quality - You need to consider the dots per inch (dpi), this is similar to the resolution of the monitor and states how clear and sharp your printed image will be.
  - a. 300 dpi - adequate for text and low resolution images and drawings
  - b. 600 dpi - Provides four times the resolution of a 300 dpi printer. Adequate quality for medium quality images.
  - c. 1200 dpi and above - High quality professional prints
2. Speed - This has two factors
  - a. Time for first page - the time it takes for the printer to print the first page once the print command is received by the printer
  - b. Pages per minute (ppm) - the number of printouts per minute. This is stated as two values. One for text and the other for graphics since graphics take a longer time.

Initial cost - The initial investment for the printer  
Operation cost - The cost of ink or toner cartridges and maintenance cost. Some printer manufacturers indicate a parameter called the printouts per toner with a 5% convergence.